

The Orion Pad Abort 1 (PA-1) Flight Test: A Propulsion Success

National Aeronautics and Space Administration

Daniel S. Jones

NASA Armstrong Flight Research Center



Human Spaceflight and the Orion MPCV

- The Constellation program Ares I architecture
 - Included the Orion Crew Exploration Vehicle (CEV)
 - Planned for utilization after the retirement of the Space Shuttle
 - Constellation program was cancelled in 2010



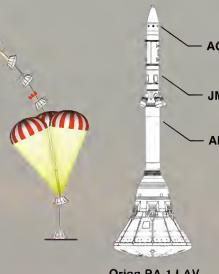
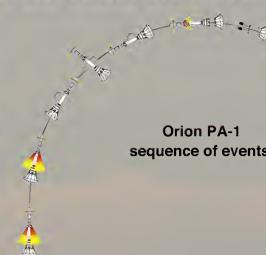
Space Launch System

- The Orion MPCV includes:
 - Launch Abort System (LAS)
 - Crew Module (CM)
 - Service Module (SM)
- The Orion Abort Flight Test (AFT) project:
 - Purpose: To conduct a series of flight tests in several launch abort scenarios to certify Orion LAS capability
 - Responsibility: The Orion Flight Test Office, at NASA JSC
 - The Orion PA-1 flight-test vehicle integration and operations effort was led by the NASA Dryden Flight Research Center (now the NASA Armstrong Flight Research Center)



Orion MPCV

Propulsion on the Orion PA-1 Vehicle



Orion PA-1 LAV

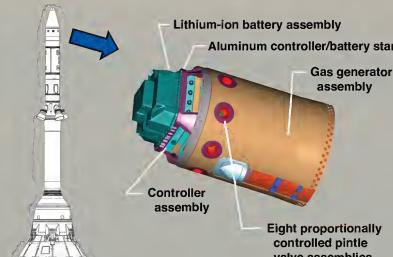
Ensuring Flight Safety

- The Orion LAS provides an abort capability in the unlikely event of a booster failure
 - Abort capability exists while on the launch pad or during mission vehicle ascent
- The architecture of any human-rated launch vehicle and spacecraft will always require the greatest level of safety
- The Orion PA-1 Flight Test Vehicle demonstrated an abort capability from the launch pad
 - Flight test occurred on May 6, 2010 at the White Sands Missile Range, in New Mexico
 - All three motors successfully demonstrated their required functions during the PA-1 flight



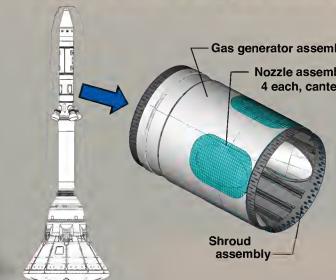
- Future flight-testing (beyond PA-1) will ensure LAS capability on the Orion MPCV for the SLS
- More detailed information on propulsion for the Orion AFT project has been published:
 - "Executive Summary of Propulsion on the Orion Abort Flight-Test Vehicles," AIAA 2012-3891

Orion PA-1 LAS ACM Overview



- Purpose: Provide pitch and yaw control to optimize the LAV abort trajectory
 - Boost phase: Utilized for LAV directional control and stabilization
 - Sustain phase: Utilized to pitch-over and reorient the LAV
 - PA-1 LAS ACM maximum thrust: ~7,000 lbf
 - PA-1 LAS ACM action time: ~35 seconds
- Developed by: Alliant Techsystems, Inc. (ATK) in Elkton, Maryland

Orion PA-1 LAS JM Overview

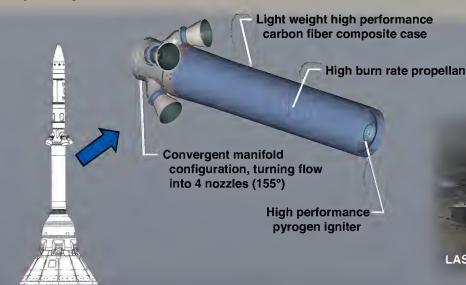


LAS JM DM-2

- Purpose: Provide the thrust force required to jettison the LAS from the Orion CM, in both the abort and nominal flight scenarios
 - Abort scenario: Utilized after the AM and ACM have performed their functions
 - Nominal scenario: Utilized with fully loaded AM and ACM propellant
 - PA-1 LAS JM nominal maximum thrust: ~44,000 lbf
 - PA-1 LAS JM action time: ~2 seconds
- Developed by: Aerojet in Sacramento, California (now part of Aerojet Rocketdyne)

Orion PA-1 LAS AM Overview

- Purpose: Provide the thrust force necessary to propel the LAV safely away from a failed booster
 - Thrust is balanced between the desire to escape quickly and the human tolerance for acceleration
 - PA-1 LAS AM nominal maximum thrust: ~500,000 lbf
 - PA-1 LAS AM action time: ~7 seconds
- Developed by: ATK in Utah



LAS AM Static Test 1 (ST-1)